during growth show such changes very prominently. The young round fishes by and by roam about the sea in shoals, led hither and thither mainly by the presence of food; though in the case of the larger and adult forms, safety or freedom from molestation may have some influence. Though so minute on escaping from the egg, their growth is, by and by, rapid, and the duration of life in such as the cod is considerable. Abundance of food, more than any special instinct, would appear to be the main cause of their migrations in the adult or semi-adult state, and that food is as varied as their haunts; in short, it embraces every sub-kingdom up to their own, for fishes and their eggs form a large share of their diet.

There would be little difficulty in adding to the sea great numbers of larval forms of any species of which eggs can be procured: yet if a few adults can be obtained in such waters at the proper season it is still an open question whether the natural process with its surroundings would not be more successful.

In the foregoing remarks I have but touched on a few of the leading features of the life-history of a food-fish; for the subject is one of vast extent, and some of the points embraced in it are by no means easily solved. We have only earnestly entered on the study of the subject in this country within the last few years, and much yet remains to be done, even in some of the most common marine fishes. However, the zoological investigator is here stimulated by the fact that all his labours directly bear on the public welfare, for it need hardly be pointed out that a thorough knowledge of the development and life-histories of our food-fishes is the first step to sound legislation and effective administration. The State has in past years spent princely sums on more or less pure science, as in the memorable voyage of the *Challenger*. There can be no doubt that at the present moment the public interests demand a searching and long-continued inquiry nearer home, viz. the exhaustive investigation of all that pertains to the food-fishes of our shores, since the problems connected therewith affect the prosperity of so large a portion of the population.

ON THE MENTAL FACULTIES OF ANTHROPOPITHECUS CALVUS.[1]

THE female Chimpanzee which has now been in the Society's Menagerie for nearly six years has attracted general notice, not only on account of her peculiar zoological characters, but perhaps still more on account of her high intelligence. This is conspicuously displayed by the remarkable degree in which she is able to understand the meaning of spoken language—a degree which is fully equal to that presented by an infant a few months before emerging from infancy, and therefore higher than that which is presented by any other brute, so far, at least, as I have met with any evidence to show. Nevertheless, the only attempts that she makes by way of vocal response are three peculiar grunting noises—one indicative of assent or affirmation, another (very closely resembling the first) of dissent or negation, and the third (quite different from the other two) of thanks or recognition of favours. In disposition she is somewhat capricious, though on the whole good-humoured, fond of her keepers, and apparently never tired of a kind of bantering play which off and on they keep up with her continually. By vocalizing in a peculiar monotone (imitative of the beginning of her own "song"), they are usually able to excite her into the performance of a remarkable series of actions. First, she shoots out her lips into the well-known tubular form (depicted in Darwin's "Expression of the Emotions," p. 141), while at the same time she sings a strange howling note interrupted at regular intervals; these, however, rapidly become shorter and shorter, while the vocalization becomes louder and louder, winding up to a climax of shrieks and yells, often accompanied with a drumming of the hind feet and a vigorous shaking of the network which constitutes her cage. The whole performance ends with a few grunts.

A year or two ago it occurred to me that I might try some psychological experiments on the intelligence of this animal. The circumstances in which she is placed, however, did not prove favourable for anything like systematic instruction. Being constantly exposed to the gaze of a number of people coming and going, and having her attention easily distracted by them, the ape was practically available for purposes of tuition only during the early hours of the morning, before the Menagerie is open to the public; and, as a rule, I did not find it convenient to attend at that time. Therefore, the results which I am about to describe do not in my opinion represent what might fairly have been expected under more favourable conditions: if the Chimpanzee could have been kept as a domestic pet for a few months (as I kept the Cebus kindly lent me for the purposes of psychological observation by this Society), there can be no doubt that many much more interesting results might have been obtained. Nevertheless, it appears to me that even those which thus far have been obtained are worthy of being placed on record; and although some of them have already been published a few months ago in my work on "Mental Evolution in Man," since that time some further progress has been made; and therefore in the present paper I will state together all the facts which have been hitherto observed.

Having enlisted the intelligent co-operation of the keepers, I requested them to ask the ape repeatedly for one straw, two straws, or three straws. These she was to pick up and hand out from among the litter in her cage. No constant order was to be observed in making these requests, but, whenever she handed a number not asked for, her offer was refused, while, if she gave the proper number, her offer was accepted, and she received a piece of fruit as payment. In this way the ape was eventually taught to associate these three numbers with their names. Lastly, if two straws or three straws were demanded, she was taught to hold one straw or two straws in her mouth until she had picked up the remaining straw, and then to hand the two straws or the three straws together. This prevented any possible error arising from her interpretation of vocal tones—an error which might well have arisen if each straw had been asked for separately.

As soon as the animal understood what was required, and had learnt to associate these three numbers with their names, she never failed to give the number of straws asked for. Her education was then extended in a similar manner from three to four, and from four to five. Here, for reasons to be presently stated, I allowed her education to terminate. But more recently one of the keepers has endeavoured to advance her instruction as far as ten. The result, however, is what might have been anticipated. Although she very rarely makes any mistake in handing out one, two, three, four, or five straws, according to the number asked for; and although she is usually accurate in handing out as many as six or seven; when the numbers eight, nine, or ten are named, the result becomes more and more uncertain, so as to be suggestive of guess-work. It is evident, however, that she understands the words seven, eight, nine, and ten to betoken numbers higher than those below them; for if she is asked for any of these numbers (*i.e.* above six), she always gives some number that is above six and not more than ten; but there is no such constant accuracy displayed in handing out the exact number named as is the case below six. On the whole, then, while there is no doubt that this animal can accurately compute any number of straws up to five, beyond five the accuracy of her computation becomes progressively diminished.

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[1] Paper read before the Zoological Society on June 4, 1889, by Prof. George J. Romanes, F.R.S.

It is to be noticed that the ape exhibits some idea of multiplication; for she very frequently (especially when dealing with numbers above five) doubles over a long straw so as to make it present two ends, and thus to appear as two straws. Any of the comparatively rare errors which she now makes in dealing with numbers below six are almost invariably due to her thus endeavouring to duplicate her straws. In this connection it is to be remembered that, owing to the method above described (whereby the ape is required to place each straw separately in her mouth until the sum asked for is completed), when any high number is demanded a considerable tax is imposed upon her patience; and, as her movements are deliberate while her store of patience is but small, it is evident to all observers that the doubling of the straws is intended to save trouble by getting the sum completed with greater rapidity than is possible when every straw is picked up separately. Of course we do not recognize these doubled straws as equivalent to two straws, and therefore the persistency with which she endeavours to palm them off as such is the more noteworthy as evidence of her idea of multiplication. Moreover, I am disposed to think that the uncertainty which attends her dealing with the numbers six and seven is more largely due to her losing patience than to her losing count; although after seven I believe that her computation of the numbers themselves becomes vague, or merged in a merely general idea of many. It may also be stated that, while picking up the straws and placing them in her mouth, she looks only at the straws themselves and not at the person who asks for them: therefore she is certainly not actuated in her responses by interpreting facial expression, unconscious gesture, &c., as is no doubt the case with many dogs which on this account are sometimes accredited by their owners with powers of "thought-reading." It is needless to add that, after asking for the number of straws required, we remain silent till the ape has handed them out.

It is not necessary—indeed it would be unreasonable—to suppose that in this process of "counting" the ape employs any system of notation. We know from our own experience that there is counting and counting, *i.e.* distinguishing between low numbers by directly appreciating the difference between two quantities of sensuous perception, and distinguishing between numbers of any amount by marking each perception with a separate sign. The extent to which the former kind of computation can be carried in the case of man has been made the subject of a careful research by Prof. Preyer, of Jena (*Sitz. Ber. d. Gesell. f. Med. u. Naturwiss.*, 1881). His experiments consisted in ascertaining the number of objects (such as dots on a piece of paper) which admit of being simultaneously estimated with accuracy, and it was found that the number admits of being largely increased by practice, until, in the case of some persons, it may rise to more than twenty. But of course in the case of a brute it is not to be expected that such a high degree of proficiency even in this non-notative kind of "counting" should be attainable. The utmost that could here be expected is that a brute should exhibit some such level of ability as is presented by a young child, or by those savages whose powers of accurate computation do not appear to extend further than numbers which we write as units.[1] It was in view of such considerations that I did not attempt to carry the education of this ape beyond the number five; and the result which has attended subsequent endeavours to teach her numbers as high as ten is, as previously remarked, exactly what might have been anticipated. It may here be added that in the only records with which I am acquainted of animals exhibiting any powers of numerical computation, these powers have not extended beyond the number five. Thus, for instance, in his well-known account of these powers as presented by rooks, Leroy says:—"To deceive this suspicious bird, the plan was hit upon of sending two men into the watch-house, one of whom passed out while the other remained to shoot the bird on returning to her nest; but the rook counted and kept her distance. Next day three went, and again she perceived that only two returned. In fine, it was found necessary to send five or six men to the watch-house in order to throw out her calculations."[1] Again, Houzeau tells us that mules used in tramways at New Orleans have to make five journeys from one end of the route to the other before they are released, and that they make four of these journeys without showing any expectation of being released, but begin to bray towards the end of the fifth.[2] Lastly, the keeper of the eared seals now in the Menagerie has recently taught one of these animals to "count" as far as five. His method is to throw pieces of fish in regular succession, which the animal catches one by one. He throws them in series of fives, and, before the commencement of any series, he tells the seal to miss the first, the second, the third, the fourth, or the fifth, as the on-lookers may dictate: the seal thereupon makes no attempt to catch the member of the series thus verbally indicated. It is only a day or two ago, however, that I witnessed this performance, and as yet I am not satisfied that the seal really "counts," because it appears to me probable that the keeper may unintentionally throw, with some slight difference in his manner of throwing, the piece of fish which he expects the seal to miss, and that it is really this slight difference in the manner of throwing which the seal perceives and acts upon. Therefore, I intend to get an arrangement fitted up whereby the pieces of fish shall be thrown mechanically. But, whatever the result of this experiment may be, I think there can now no longer be any question that it lies within the capacity of animal intelligence to "count" correctly (in the sense already explained) as far as five, and even to show a well-marked appreciation, although progressively a more and more uncertain one, of numbers lying between five and ten.

The only other direction in which I have thus far subjected the Chimpanzee to psychological experiment has been in that of attempting to teach her the names of colours. It appeared to me that if I could once succeed in getting her thoroughly well to know the names of black, white, red, green, and blue, a possible basis might be laid for many further experiments wherein these five colours could be used as signs of artificially associated ideas. The result, however, of attempting to teach her the names of colours has been so uniformly negative, that I am disposed to think the animal must be colour-blind. It is perhaps desirable to state the facts which have led me to entertain this as their most probable interpretation.

The method adopted in these experiments was to obtain from the importers of Oriental matting a number of brightly and uniformly coloured pieces of straw—each piece being either white, black, red, green, or blue. Taking the straws two by two of different colours, on each occasion the ape was invited to choose the straw of the colour named from the one whose colour was not named, and, of course, on choosing correctly she was rewarded with a piece of fruit. In this way she quickly learnt to distinguish between the white straws and the straws of any other colour; but she never could be taught to go further. Now the distinction between the white straws and the straws of any other colour is a distinction which could have been drawn by an eye that is colour-blind; and from the fact that the ape is always able to perceive this distinction (she will search long and patiently for a straw of any colour when told that it occurs somewhere in the general litter of white straws constituting her bed, and eventually picks it out), while she cannot be taught to distinguish any of the others, I conclude that her failure in this respect is not due to any want of intelligence, but to some deficiency in her powers of colour-perception.

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[1] See, for instance, Galton, "Tropical South Africa," p. 213

[1] "Letters, &c."

[2] "Fac. Ment. des Anim.," tom. ii. p. 207.

NOTES.

THE annual meeting for the election of Fellows of the Royal Society was held at the Society's rooms in Burlington House, on June 6, when the following gentlemen were elected :—John Aitken, Dr. Edward Ballard, Alfred Barnard Basset, Horace T. Brown, Latimer Clark, Prof. David Douglas Cunningham, Lazarus Fletcher, William Botting Hemsley, Charles Thomas Hudson, Prof. Thomas McKenny Hughes, Edward B. Poulton, Prof. William Johnson Sollas, Charles Todd, Herbert Tomlinson, Prof. Gerald F. Yeo.

THE statue of Le Verrier is to be unveiled in the court of the Paris Observatory on June 25.

HERR VICTOR APFELBECK, the entomologist, will shortly start, in behalf of the Bosnian Government, on a journey of research in Herzegovina. Last year he discovered in Southern Bosnia five new species of eyeless cave beetles, and his investigations excited much interest among entomologists.

ACCORDING to the *British Medical Journal*, the programme of the Leeds meeting of the British Medical Association in August next "is developing in such manner as to afford the ample promise of a meeting of great scientific as well as social interest, and one which will be worthy of the traditions of this great medical centre."

MR. JOHN FREDERICK LA TROBE BATEMAN, F.R.S., died on Monday morning at Moor Park, Farnham, at the age of seventy-nine, after a severe illness. Mr. Bateman was well known as the engineer who supplied Glasgow with water from Loch Katrine.

THE death of Eugen Ferdinand von Homeyer, the eminent ornithologist, is announced. He had been President of the Ornithological Society at Berlin, was the author of several works, and possessed the largest existing collection of European birds. He was born at Herdin, near Anklam, in 1809, and died at Stolp, in Prussia, on June 1.

INFORMATION has been received in Berlin of the death of Dr. Bernhard Weissenborn, the zoologist to the German Cameroons Expedition, from a fever contracted through the hardships of the work and the bad climate.

GERMAN papers record the death of Dr. C. Jessen, the naturalist, formerly Professor at Greifswald, and lately at the Berlin University. He was sixty-eight years of age.

AT a meeting of the Royal Horticultural Society on Tuesday, a paper on orchids was read by Mr. H. Veitch. In the discussion which followed the reading of this paper, various speakers referred with regret to the death of Prof. Reichenbach, and to the strange provisions of his will, by which botanists of the present generation will be prevented from studying his fine collection of orchids. Mr. Thiselton Dyer invited those interested in the nomenclature of orchids to put themselves in communication with the Kew Herbarium, and it was stated that Messrs. Veitch and Sander could furnish many duplicates of the examples which were to be locked up under the will of Reichenbach. Sir T. Lawrence spoke of an orchid which had been in this country to his knowledge for fifty years.

THE June number of the *Kew Bulletin* opens with an instructive paper on Jamaica cogwood. This is one of the most valuable timber-trees in Jamaica, yet until recently its flowers and fruit had not been received in this country, so that, as the writer points out, the position of the plant in botanical classification had been left in doubt. Good herbarium specimens, including flowers and fruit, have lately been sent to Kew by Mr. W. Fawcett, Director of Public Gardens and Plantations in Jamaica; and from this material Prof. Oliver has determined the cogwood to be a species of *Zizyphus*, a genus not previously recorded from Jamaica. *Zizyphus* is the Jujube or Lotus genus of *Rhamneæ*, and the fruits of several species, such as *Z. vulgaris* and *Z. Jujuba*, have an agreeable flavour, and are commonly eaten. Besides this paper, there are contributions on cocoa-nut coir from Lagos, a wheat pest in Cyprus, patchouli, P'u-êrh tea, and agricultural industries at the Gambia.

WE take the following from *Allen's Indian Mail* :—"The appointment of Mr. A. Hartless from the Royal Gardens, Kew, to fill the vacancy in the staff of the Botanic Gardens at Shippur has given much satisfaction. This gentleman is a first-class botanist, and will no doubt contribute hereafter many original and important observations on the flora of India."

IN addition to the papers announced to be read at the ordinary meeting of the Royal Meteorological Society on June 19, a communication will be made on the recent thunderstorms, and a number of photographs of lightning will be exhibited.

A VIOLENT shock of earthquake, accompanied by local subterranean rumblings, was felt at Brest on June 7 at a quarter past one o'clock, its direction being from north to south. The shock is said to have resembled the vibration caused by the firing of a gun of large calibre. On the same day a shock of earthquake was felt at New Bedford, in Massachusetts.

ON April 13 and 14 a volcanic eruption occurred on Oshima Island, Japan. It is said that upwards of 300 houses were destroyed, and that 170 persons were killed by being buried beneath the ruined buildings.

ACCORDING to the *Japan Weekly Mail*, an earthquake of a most unusual character was recorded at 2h. 7m. 41s. p.m., on Thursday, April 18, in the Seismological Observatory of the Imperial University, Tokio. The peculiarity lies, not in its violence, but in the extreme slowness of its oscillations. The beginning of the shock had all the characteristics of the ordinary earthquake, but gradually the motion augmented, until at a certain stage of the shock it reached 17 millimetres, but the ground swayed so gently that the house did not vibrate visibly, nor were the senses alive to it. It took from four to seven seconds to complete one oscillation—a most unusual phenomenon, and one never before noted in the Observatory. The motion was almost entirely confined to the horizontal plane, and mostly south to north, but there were a few vertical motions of equally slow periods. This state of things lasted for 10 minutes 36 seconds. Prof. West, of the Engineering College, observed the water in a small pond to oscillate gently from north to south. At one time the water-level fell about 2 inches on one side of the pond, and exposed the bank, while, a few seconds later, the water immersed it nearly to the same depth, exposing the opposite bank, and this process continued for a quarter of an hour. "Slow oscillations of this nature have been called earth-pulsations, and these usually take place where there is a destructive earthquake or a submarine disturbance going on at a great distance. Earth-pulsations are known to have caused slow oscillations of the water in lakes. From this fact it may not be unreasonable to conjecture that a terrestrial or submarine agitation of unusual